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in the use of both m.m. and mm. several times on the same page, and in the recurrence of various misspelled names. It is certainly amusing to learn that an article can easily be made by a *tin smith*. One notices, also, an occasional slip of the pen, as a result of which figure and text do not always agree. Thus, the mechanical stage, shown in figure 69, does not possess verniers, despite the statement in the description of the cut, and the absence of this feature is undoubtedly a serious defect in the construction of the stage as compared with that of another maker which is shown in the adjacent figure. The excessive number and length of the foot-notes in the book mar the beauty of the page, and many of them might easily have been incorporated in the text. It is further true that the constant use of vulgar fractions, which have no place in a scientific text-book, is another point to be justly criticised. Their employment also is not limited to such as are difficult to translate into decimal figures, but $\frac{1}{10}$, $\frac{5}{100}$ mm., etc., are of constant occurrence.

While it would be manifestly unfair to give an idea of the book based merely on these criticisms of minor details, it is evidently impossible to do more than hint at some of the many advantageous features which it contains. The synopses of the steps in the preparation of paraffin and collodion sections are of exceeding value to any student and will doubtless save much time and many errors. Throughout the book one finds very complete cross references and satisfactory bibliographical notes which will be of constant use to the worker. Every topic is completely and concisely discussed; the order is clear and logical, and one is at a loss to suggest points that have been overlooked.

The chapter on Photo-micrography deserves especial mention. It includes much that cannot be found elsewhere and is altogether the best concise statement of the subject which is accessible. This chapter is worth more than the price of the entire work. Like the rest of the book, it is copiously illustrated; the figures are exceptionally well chosen, and among them are a couple of splendid photo-micrographs from the work of Mrs. Gage, who also drew all the original figures by which the work is illustrated.

As a whole, the work is a useful and valuable addition to the manuals accessible to the American teacher and is destined to be widely and generally used.

HENRY BALDWIN WARD.

The Chances of Death and other Studies in Evolution. KARL PEARSON. Edward Arnold, London and New York. Vol. I., pp. ix+388; vol. II., pp. 460. \$8.00.

Professor Pearson's essays and lectures fall into three groups. One of these is concerned with the theory of deviations from the mean in its application to vital and social phenomena, another with a criticism of certain popular writers who have exploited science for the benefit of religion and politics, and the third with studies in folk-lore and folk-customs, viewed from the light they cast on the evolution of society. All of the essays are of great contemporary interest, and have to a considerable degree the unity claimed by the author, 'the endeavor to see all phenomena, physical and social, as a connected growth, and describe them as such in the briefest formula possible.'

The essays on variation in this volume, and the series of papers on the mathematical theory of evolution published in the *Transactions and Proceedings* of the Royal Society since 1894, represent a scientific advance of great importance. Modern science pursues two main methods; it is either quantitative or genetic. The exact sciences have found in measurement a method of description so efficient, economical and universal that it must be regarded as the goal of those sciences in which description is only qualitative. The genetic method has, however, since the publication of the 'Origin of Species by Means of Natural Selection,' demonstrated its validity. Could we add to the genetic method of natural science the quantitative method of exact science a great advance would be assured.

It is not possible to describe in a few words what has in fact been accomplished since Quetelet applied the Gauss theory of the distribution of errors to vital phenomena. If any trait, such as the height of men, depends on a great number of small causes, some tending to make them smaller and an equal number tending to

make them larger, then theoretically the deviations from the mean will be distributed in a certain symmetrical fashion, and measurements show that such a distribution does in fact approximately obtain. According to the Darwinian theory such chance variations as proved useful have by natural selection been preserved, and have given rise to new species and to organic evolution. The quantitative study of these variations, especially in their relations to heredity, is, I believe, the most pressing problem of biological science. The small amount of work hitherto accomplished has been chiefly carried out in England by Mr. Galton, Mr. Weldon, Mr. Bateson and Mr. Pearson. Mr. Galton has assumed the validity of the theoretical distribution. Mr. Pearson has shown that the distribution may be complex and non-symmetrical, and has subjected it to mathematical analyses.

Turning now to the essays in this book, which are of special value because the scientific papers of the author are of such a technical character, as to make them unintelligible to many naturalists, we find the first to be on 'The Chances of Death.' Mr. Pearson explains the theory of deviations from the mean, and shows how mortality statistics may be analyzed into five 'skew' curves. Thus 'old age' mortality includes about one-half of all deaths. The maximum of the curve is at about 71 years, but it has a 'skewness' toward youth of 0.345. The mean is at about 65 years, with a 'standard deviation' of about 13.5 years and a limit on the old age side of 106.5 years. Components are then found representing the mortality of middle age, of youth, of childhood and of infancy. In the last case Mr. Pearson found that to secure a frequency curve it was necessary to take account of antenatal mortality, and that the curve discovered corresponds fairly well with the facts.

It is quite evident that the regular frequency curve does not represent mortality statistics or, indeed, most social and vital statistics. I have in several publications claimed that the ordinary frequency curve can in all actual cases be but an approximation. Mr. Pearson's skew curves allow us to express the facts with greater approximation, just as the orbits of planets are

more nearly ellipses than circles. But, in fact, the orbits of the planets are endlessly complex, and so are the distributions of errors or deviations. Mr. Pearson claims to give a simple curve for infancy, but the material is not homogeneous. Antenatal mortality is due to causes different from those of infant mortality. The mortality of infants of the two sexes, of different races, of different classes, of those born at different seasons of the year, of those legitimate and those illegitimate, of those nursed by the mother and those brought up by hand, etc., has each a different distribution. In antenatal mortality there is a maximum at each four weeks, a greater maximum in the second and third months, etc. The curve for infancy would, in my opinion, need to be further broken up, quite beyond the possibility of mathematical analysis, in order to express the facts.

The second essay analyzes certain alleged results of Monte Carlo Roulette, and shows that they are deficient in short runs to an almost impossible degree. Presumably the published figures do not represent the actual falls of the ball, or it would be easy to 'break the bank.' The author does not give this explanation, and apparently does not notice that in one case the zeros (where the money goes to the bank) are only 499 instead of a most probable 840, a return perhaps intended to encourage the gambler. I must admit that I do not think that Mr. Pearson has made the best possible use of his time in tossing shillings 25,000 times, etc., in order to test the laws of probability. He might as well measure the sides of 25,000 right-angled triangles in order to see whether the square of the hypotenuse is really equal to the sum of the squares of the other two sides.

The third essay, entitled 'Reproductive Selection,' is concerned with a statistical study of the size of families. The material is of much theoretical interest and of the greatest practical importance. If there is a complete correlation between fertility of parent and offspring, we might expect those having large families to supplant quickly all others, whereas it is not commonly supposed that those most fertile are those most fit for society. From 4,390 families, mostly of middle and upper Anglo-Saxon stock, Mr. Pearson finds that the most frequent

family, the 'mode,' is between two and three; the median family is about $3\frac{1}{2}$ and the mean family one larger. The median fertility is, however, about $5\frac{1}{2}$, and it follows from this that the most fertile quarter of the parents produce one half of the next generation. The same general relations hold for the extensive statistics of Copenhagen families collected by Rubin and Westergaard, but the fertility is greater. In both cases there is a deficiency, according to the theoretical distribution, of families of five and six children, due probably, as Mr. Pearson holds, to voluntary control. I cannot, however, agree with him that the curve shows that control is not exercised in the case of families of other sizes, or that in the case of no children it is excessive. In the latter case there are special anatomical and physiological causes producing sterility, which would not be factors in the amount of fertility.

Mr. Pearson finds that there is a selective death-rate increasing with increased fertility, but it would only slightly check 'reproductive selection,' and he concludes that in the case of civilized man natural selection at present appears to be quite secondary to reproductive selection as a factor of progressive evolution. An extreme Neo-Darwinian might, indeed, find it difficult to tell us why families do not increase indefinitely in size, or why infant mortality does not eliminate itself. We must believe that deviations from the mean are not always stable hereditarily and are in definite directions. The degree to which individual fertility is a stable variation can only be determined by statistics not yet collected. It is, however, clear that race or class fertility, whether due to physiological or psychological causes, will in a comparatively short time produce great changes in every race and in the survival of races. Thus the Bretons are supplanting other French stocks, and our New England stock is in danger of extermination.

The essay on 'Variation in Man and Woman' occupies one-third of the first volume. As the result of some 155 cases of variation for both sexes, covering a wide field, Mr. Pearson finds that woman is, relatively to size, not less, but probably slightly more, variable than man. This is contrary to the common opinion, but

had been proved previously by Mr. Galton for sensation-areas. The variation in brain-weight is of special interest, but the data are so conflicting that they are not of great value; the coefficient of variation is, however, sensibly the same for the two sexes. Mr. Pearson criticises somewhat bitterly those who have assumed, on insufficient evidence, the greater variability of the male and drawn therefrom sociological conclusions. I think, however, that the experience of those who have taught both men and women will favor the greater intellectual variability of the male. The collation of examination papers marked without reference to these matters would be of interest. Supposing the male to be more variable in intellect and character, as seems sufficiently evident from the history of civilization, it would still remain undecided whether this were due to 'nature' or 'nurture,' and sociological inferences can only be drawn with caution.

This volume contains three essays criticising, respectively, Mr. Kidd's 'Social Evolution,' Lord Salisbury's 'President's Address' before the British Association and Mr. Balfour's 'Foundations of Belief.' Mr. Pearson has rather an easy task. Mr. Kidd's book received abundant attention and was lauded by Mr. Wallace in *Nature*, but it is already half forgotten. Mr. Pearson's arguments for the comparative unimportance of intra-group selection for human progress are, however, deserving of consideration. Most men of science will agree with Mr. Pearson's arraignment of Lord Salisbury and Mr. Balfour. It is a particularly futile form of argument to pass from *ignoramus* to *ignorabimus* and thence to *credendum est*. Mr. Pearson holds that the comparative orthodoxy of the Conservative leaders was of much advantage to them in the last elections. The writing of books on science and philosophy is, however, a kind of demagoguery of which we should be glad to see some trace in America. Mr. Pearson is undoubtedly correct in stating that thoughtful men of science do not hold the materialistic views attributed to them by Mr. Balfour, but I am not sure that his own idealism helps greatly in treating the problems of physical science. When it is said that in science we are concerned not with phenomena,

but with 'a rational analysis of the contents of the human mind,' this is a statement that does not essentially affect the methods of science; but it seems somewhat dangerous to attempt to lessen the difficulties in the way of correlating atoms and the ether with other physical phenomena by regarding them as 'conceptual limits.'

The only essay in the first volume not yet noticed is concerned with the place of women in society, and with the relations of individualism and socialism—subjects which are more or less distinctly brought forward in many places. The second volume is, indeed, chiefly concerned with them, though indirectly, from the point of view of folk-customs and folk-lore. The four essays included in it are entitled 'Woman as Witch,' 'Ashiepatle,' 'Kindred Group-Marriage' and 'The German Passion-Play.' Limits of space do not permit me to give an account of these, and limitations of knowledge make me incompetent to criticise them. Mr. Pearson attributes great importance to a mother-age and its customs, and emphasizes the fact that mediæval Western Christianity was a product of the Teutonic folk-spirit.

Mr. Pearson's essays and lectures are *actual* to an unusual degree. The scientific and social problems treated by him are those most pressing for solution and those most likely to become predominant in the course of the next twenty years. It is not too much to say that these volumes should be read by every man of science.

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SCIENTIFIC JOURNALS.

AMERICAN CHEMICAL JOURNAL, AUGUST.

On the Oximes of Mucophenoxychloric and Mucophenoxybromic Acids: By H. B. HILL and J. A. WIDTSOE. *On the Action of Aluminic Chloride and Benzol upon Mucochloryl Chloride, Mucobromyl Bromide, and the Corresponding Acids:* By H. B. HILL and F. L. DUNLAP. These papers contain the results of investigations which have been carried out under Professor Hill's directions. It had been shown that mucochloric and mucobromic acids, when treated with hydroxylamine, formed normal

oximes, which would indicate the presence of an aldehyde group in the acids. On the other hand, the bromanhydrides could be converted into crotonolactones by reduction, indicating an anhydride structure. The tautomerism of these acids has been the basis of the present work. Hill and Cornelson had attempted to discriminate between the two forms by a study of the action of hydroxylamine on the methylester of the acid, expecting to find that one of the forms would react readily, the other with difficulty. Although the free acids acted very quickly, the action with the methylester was very slight. When, however, one hydrogen of the acid was replaced by the phenoxy group, a substance was obtained whose ester acted readily and formed a substance identical with the ester made from the oximes by the action of methyl-iodide on the silver salt. The oximes and their derivatives were prepared and studied during the course of this investigation. The simplest explanation that could be offered to explain the conversion of the acids through their bromanhydrides into crotonolactones was that the acids were oxylactones. This was tested as follows: If the acid has an aldehyde structure it should, on treatment with aluminic chloride and benzol, yield an aldehyde phenylketone, while a substance belonging to the class of oxylactones should form a dichlorophenylcrotonic acid. The latter product was, in fact, the one obtained, and the authors consider the evidence sufficient to warrant the conclusion that the acid and its chloranhydride have the lactone structure.

On Certain Derivatives of Brommaleic and Chlormaleic Acid-Aldehydes: By H. B. HILL and E. T. ALLEN. The authors repeated the experiments of Limpricht which led to the formation of an acid-aldehyde of fumaric acid; but were unable to isolate any crystalline compound. The viscous liquid which they obtained had, however, the properties of an aldehyde. In attempts to prepare some derivative of this they obtained a product which they showed to be brommaleic acid aldoxime. As this substance had not been previously prepared, its properties and many of its derivatives were studied. All attempts to prepare the acid itself failed. The corresponding chlorine compound can be made by the action of chlorine upon pyromucic acid.